General

Guideline Title

General recommendations on immunization. Recommendations of the Advisory Committee on Immunization Practices (ACIP).

Bibliographic Source(s)

National Center for Immunization and Respiratory Diseases. General recommendations on immunization. Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Surveill Summ. 2011 Jan 28;60(2):1-64. [239 references] PubMed

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Kroger AT, Atkinson WL, Marcuse EK, Pickering LK, Advisory Committee on Immunization Practices (ACIP) Centers for Disease. General recommendations on immunization: recommendations of the Advisory Committee on Immunization Practices (ACIP) [published errata appear in MMWR Morb Mortal Wkly Rep 2007 Mar 23;56(11):256]. MMWR Recomm Rep 2006 Dec 1;55(RR-15):1-48.

Centers for Disease Control and Prevention (CDC), Advisory Committee on Immunization Practices (ACIP). Update: recommendations from the Advisory Committee on Immunization Practices (ACIP) regarding administration of combination MMRV vaccine. MMWR Morb Mortal Wkly Rep 2008 Mar 14;57(10):258-60.

The Advisory Committee on Immunization Practices (ACIP) General Recommendations Work Group (GRWG) revises the General Recommendations on Immunization every 3 to 5 years.

Recommendations

Major Recommendations

Note from the National Guideline Clearinghouse and the Centers for Disease Control and Prevention (CDC): This report is a revision of the *General Recommendations on Immunization* and updates the 2006 statement by the Advisory Committee on Immunization Practices (ACIP). Notable revisions to the 2006 recommendations include 1) revisions to the tables of contraindications and precautions to vaccination, as well as a separate table of conditions that are commonly misperceived as contraindications and precautions; 2) reordering of the report content, with vaccine risk-benefit screening, managing adverse reactions, reporting of adverse events, and the vaccine injury compensation program presented immediately after the discussion of contraindications and precautions; 3) stricter criteria for selecting an appropriate storage unit for vaccines; 4) additional guidance for maintaining the cold chain in the event of unavoidable temperature deviations; and 5) updated revisions for vaccination of patients who have received a hematopoietic cell transplant. The most recent ACIP recommendations for each specific vaccine should be consulted for comprehensive discussion. This report, ACIP recommendations for each vaccine, and other information about vaccination can be accessed at

the CDC Web site .

Timing and Spacing of Immunobiologics

General Principles for Vaccine Scheduling

Optimal response to a vaccine depends on multiple factors, including the type of vaccine, age of the recipient, and immune status of the recipient. Recommendations for the age at which vaccines are administered are influenced by age-specific risks for disease, age-specific risks for complications, age-specific responses to vaccination, and potential interference with the immune response by passively transferred maternal antibodies. Vaccines are recommended for members of the youngest age group at risk for experiencing the disease for which efficacy and safety have been demonstrated.

Certain products, including inactivated vaccines, toxoids, recombinant subunit vaccines, polysaccharide conjugate vaccines, and live vaccines, require ≥2 doses to elicit an adequate antibody response. Tetanus and diphtheria toxoids require booster doses to maintain protective antibody concentrations. Unconjugated polysaccharide vaccines do not induce T-cell memory, and additional doses (although they elicit the same or a lower antibody concentration) might increase the level of protection. Conjugation with a protein carrier improves the effectiveness of polysaccharide vaccines by inducing T-lymphocyte-dependent immunologic function. Many vaccines that stimulate both cell-mediated immunity and neutralizing antibodies (e.g., live, attenuated virus vaccines) usually can induce prolonged immunity, even if antibody titers decline over time. Subsequent exposure to such viruses usually results in a rapid anamnestic antibody response without viremia.

Approximately 90%–95% of recipients of a single dose of certain live vaccines administered by injection at the recommended age (i.e., measles, rubella, and yellow fever vaccines) develop protective antibodies, generally within 14 days of the dose. For varicella and mumps vaccines, 80%-85% of vaccinees are protected after a single dose. However, because a limited proportion (5%–15%) of measles-mumps-rubella (MMR) or varicella vaccinees fail to respond to 1 dose, a second dose is recommended to provide another opportunity to develop immunity. Of those who do not respond to the first dose of MMR or varicella vaccine, 97%–99% respond to a second dose.

The *Recommended Immunization Schedules for Persons Aged 0 Through 18 Years* and the *Recommended Adult Immunization Schedule* are revised annually. Physicians and other health-care providers should ensure that they are following the most up-to-date schedules, which are available from the CDC Web site: http://www.cdc.gov/vaccines .

Spacing of Multiple Doses of the Same Antigen

Vaccination providers should adhere as closely as possible to the recommended vaccination schedules (see Table 1 below). Administration at recommended ages and in accordance with recommended intervals between doses of multidose antigens provide optimal protection.

Administration of doses of a multidose vaccine using intervals that are shorter than recommended might be necessary in certain circumstances, such as impending international travel or when a person is behind schedule on vaccinations but needs rapid protection. In these situations, an accelerated schedule can be implemented using intervals between doses that are shorter than those recommended for routine vaccination. The accelerated or minimum intervals and ages for scheduling catch-up vaccinations are available at http://www.cdc.gov/vaccines . Vaccine doses should not be administered at intervals less than these minimum intervals or at an age that is younger than the minimum age.*

*During measles outbreaks, if cases are occurring among infants aged <12 months, measles vaccination of infants as young as 6 months can be undertaken as an outbreak control measure. However, doses administered at ages <12 months should not be counted as part of the series (Source: CDC. Measles, mumps, and rubella vaccine use and strategies for elimination of measles, rubella, and congenital rubella syndrome and control of mumps: recommendations of the Advisory Committee on Immunization Practices [ACIP]. MMWR 1998;47[No. RR-8])

Before administering a vaccine dose, providers might need to verify that all previous doses were administered after the minimum age and in accordance with minimum intervals (see Table 1 below). In clinical practice, vaccine doses occasionally are administered at intervals less than the minimum interval or at ages younger than the minimum age. Doses administered too close together or at too young an age can lead to a suboptimal immune response. However, administering a dose a few days earlier than the minimum interval or age is unlikely to have a substantially negative effect on the immune response to that dose. Vaccine doses administered ≤4 before the minimum interval or age are considered valid; however, local or state mandates might supersede this 4-day guideline.† (Day 1 is the day before the day that marks the minimum age or minimum interval for a vaccine.) Because of the unique schedule for rabies vaccine, the 4-day guideline does not apply to this vaccine. Doses administered ≥5 days earlier than the minimum interval or age of any vaccine should not be counted as valid doses and should be repeated as age-appropriate. The repeat dose should be spaced after the invalid dose by the recommended minimum interval (see Table 1 below). For example, if the first and second doses of *Haemophilus influenzae* type b (Hib) were administered only 14 days apart, the second dose would be invalid and need to be repeated because the minimum interval from dose 1 to dose 2 is 4 weeks. The repeat dose should be administered ≥4 weeks after the invalid dose (in this case, the second). The repeat dose is counted as the second valid dose.

†In certain situations, local or state requirements might mandate that doses of selected vaccines be administered on or after specific ages. For example, a school entry requirement might not accept a dose of MMR or varicella vaccine administered before the child's first birthday. ACIP recommends that physicians and other health-care providers comply with local or state vaccination requirements when scheduling and administering vaccines.

If the first dose in a series is given ≥5 days before the recommended minimum age, the dose should be repeated on or after the date when the child reaches at least the minimum age. If the vaccine is a live vaccine, ensuring that a minimum interval of 28 days has elapsed from the invalid dose is recommended. For example, if the first dose of varicella vaccine were inadvertently administered at age 10 months, the repeat dose would be administered no earlier than the child's first birthday (the minimum age for the first dose). If the first dose of varicella vaccine were administered at age 11 months and 2 weeks, the repeat dose should be administered no earlier than 4 weeks thereafter, which would occur after the first birthday.

Certain vaccines (e.g., adult tetanus and diphtheria toxoids [Td]; pediatric diphtheria and tetanus toxoids [DT]; and tetanus toxoid) produce increased rates of local or systemic reactions in certain recipients when administered more frequently than recommended. Careful record keeping, maintenance of patient histories, use of immunization information systems, and adherence to recommended schedules can decrease the incidence of such reactions without adversely affecting immunity.

Table 1. Recommended and Minimum Ages and Intervals Between Vaccine Doses*†

Vaccine and Dose Number	Recommended Age for this Dose	Minimum age for this dose	Recommended Interval to Next Dose	Minimum Interval to Next Dose
Hepatitis B (HepB)-1§	Birth	Birth	1-4 mos	4 wks
HepB-2	1-2 mos	4 wks	2-17 mos	8 wks
HepB-3¶	6-18 mos	24 wks	—	—
Diphtheria–tetanus-acellular pertussis (DTaP)-1§	2 mos	6 wks	2 mos	4 wks
DTaP-2	4 mos	10 wks	2 mos	4 wks
DTaP-3	6 mos	14 wks	6-12 mos	6 mos**,††
DTaP-4	15-18 mos	12 mos	3 yrs	6 mos**
DTaP-5	4-6 yrs	4 yrs	—	—
Haemophilus influenzae type b (Hib)-1§,§§	2 mos	6 wks	2 mos	4 wks
Hib-2	4 mos	10 wks	2 mos	4 wks
Hib-3¶¶	6 mos	14 wks	6-9 mos	8 wks
Hib-4	12-15 mos	12 mos	—	—
Inactivated poliovirus (IPV)-1§	2 mos	6 wks	2 mos	4 wks
IPV-2	4 mos	10 wks	2-14 mos	4 wks
IPV-3	6-18 mos	14 wks	3-5 yrs	6 mos
IPV-4***	4-6 yrs	4 yrs	—	—
Pneumococcal conjugate vaccine(PCV)-1§§	2 mos	6 wks	8 wks	4 wks
PCV-2	4 mos	10 wks	8 wks	4 wks
PCV-3	6 mos	14 wks	6 mos	8 wks

Vaccine and Dose Number	Recommended Age for this Dose	Minimum age for this dose	Recommended Interval to Next Dose	Minimum Interval to Next Dose
PCV-4	12-15 mos	12 mos	—	—
Measles-mumps-rubella (MMR)-1[†††]	12-15 mos	12 mos	3-5 yrs	4 wks
MMR-2[†††]	4-6 yrs	13 mos	—	—
Varicella (Var)-1[†††]	12-15 mos	12 mos	3-5 yrs	12 wks[§§§]
Var-2[†††]	4-6 yrs	15 mos	—	—
Hepatitis A (HepA)-1[+]	12-23 mos	12 mos	6-18 mos[**]	6 mos[**]
HepA-2	≥18 mos	18 mos	—	—
Influenza inactivated[¶¶¶]	≥6 mos	6 mos[****]	1 mo	4 wks
Live, attenuated influenza vaccine (LAIV) (intranasal)[¶¶¶]	2-49 yrs	2 yrs	1 mo	4 wks
Quadrivalent meningococcal conjugate vaccine (MCV4)-1[††††]	11-12 yrs	2 yrs	5 yrs	8 wks
MCV4-2	16 yrs	11 yrs (+8 wks)	—	—
Quadrivalent meningococcal polysaccharide vaccine (MPSV4)-1[††††]	—	2 yrs	5 yrs	5 yrs
MPSV4-2	—	7 yrs	—	—
Tetanus-diphtheria	11-12 yrs	7 yrs	10 yrs	5 yrs
Tetanus-diphtheria acellular pertussis (Tdap) [§§§§]	≥11 yrs	7 yrs	—	—
Pneumococcal polysaccharide (PPSV)-1	—	2 yrs	5 yrs	5 yrs
PPSV-2[¶¶¶¶]	—	7 yrs	—	—
Human papillomavirus (HPV)-1[*****]	11-12 yrs	9 yrs	2 mos	4 weeks
HPV-2	11-12 yrs (+2 mos)	9 yrs (+4 wks)	4 mos	12 wks[†††††]
HPV-3[†††††]	11-12 yrs (+6 mos)	9 yrs (+24 wks)	—	—
Rotavirus-1[§§§§§]	2 mos	6 wks	2 mos	4 wks
Rotavirus-2	4 mos	10 wks	2 mos	4 wks
Rotavirus-3[¶¶¶¶¶]	6 mos	14 wks	—	—
Zoster[******]	≥60 yrs	60 yrs	—	—

[*] Combination vaccines are available. Use of licensed combination vaccines is generally preferred to separate injections of their equivalent

component vaccines. When administering combination vaccines, the minimum age for administration is the oldest age for any of the individual components; the minimum interval between doses is equal to the greatest interval of any of the individual components.

† Information on travel vaccines, including typhoid, Japanese encephalitis, and yellow fever, is available at http://www.cdc.gov/travel. Information on other vaccines that are licensed in the United States but not distributed, including anthrax and smallpox, is available at http://www.bt.cdc.gov.

§ Combination vaccines containing the hepatitis B component are available (see Table 2 in the original guideline document). These vaccines should not be administered to infants aged <6 weeks because of the other components (i.e., Hib, DTaP, HepA, and IPV).

¶ HepB-3 should be administered at least 8 weeks after HepB-2 and at least 16 weeks after HepB-1 and should not be administered before age 24 weeks.

** Calendar months.

†† The minimum recommended interval between DTaP-3 and DTaP-4 is 6 months. However, DTaP-4 need not be repeated if administered at least 4 months after DTaP-3.

§§ For Hib and PCV, children receiving the first dose of vaccine at age ≥7 months require fewer doses to complete the series.

¶¶ If polyribosylribitol phosphate-meningococcal outer membrane protein (PRP-OMP) (Pedvax-Hib®, Merck Vaccine Division) was administered at age 2 and 4 months, a dose at age 6 months is not necessary.

*** A fourth dose is not needed if the third dose was administered at ≥4 years and at least 6 months after the previous dose.

††† Combination measles-mumps-rubella-varicella (MMRV) vaccine can be used for children aged 12 months–12 years. See the original guideline document for details.

§§§ The minimum interval from VAR-1 to VAR-2 for persons beginning the series at age ≥13 years is 4 weeks.

¶¶¶ One dose of influenza vaccine per season are recommended for most persons. Children aged <9 years who are receiving influenza vaccine for the first time or who received only one dose the previous season (if it was their first vaccination season) should receive 2 doses this season.

**** The minimum age for inactivated influenza vaccine varies by vaccine manufacturer. See package insert for vaccine-specific minimum ages.

†††† Revaccination with meningococcal vaccine is recommended for previously vaccinated persons who remain at high risk for meningococcal disease. (Source: CDC. Updated recommendations from the Advisory Committee on Immunization Practices (ACIP) for revaccination of persons at prolonged increased risk for meningococcal disease. MMWR 2009;58:[1042–3]).

§§§§ Only 1 dose of Tdap is recommended. Subsequent doses should be administered as Td. For one brand of Tdap, the minimum age is 11 years. For management of a tetanus-prone wound in persons who have received a primary series of tetanus-toxoid–containing vaccine, the minimum interval after a previous dose of any tetanus-containing vaccine is 5 years.

¶¶¶¶ A second dose of PPSV 5 years after the first dose is recommended for persons aged ≤65 years at highest risk for serious pneumococcal infection and those who are likely to have a rapid decline in pneumococcal antibody concentration. (Source: CDC. Prevention of pneumococcal disease: recommendations of the Advisory Committee on Immunization Practices [ACIP]. MMWR 1997;46[No. RR-8]).

***** Bivalent HPV vaccine is approved for females aged 10–25 years. Quadrivalent HPV vaccine is approved for males and females aged 9–26 years.

††††† The minimum age for HPV-3 is based on the baseline minimum age for the first dose (i.e., 108 months) and the minimum interval of 24 weeks between the first and third dose. Dose 3 need not be repeated if it is administered at least 16 weeks after the first dose.

§§§§§ The first dose of rotavirus must be administered at age 6 weeks through 14 weeks and 6 days. The vaccine series should not be started for infants aged ≥15 weeks, 0 days. Rotavirus should not be administered to children older than 8 months, 0 days of age regardless of the number of doses received between 6 weeks and 8 months, 0 days of age.

¶¶¶¶¶ If 2 doses of Rotarix (GlaxoSmithKline) are administered as age appropriate, a third dose is not necessary.

****** Herpes zoster vaccine is recommended as a single dose for persons aged ≥60 years.

Simultaneous Administration

Simultaneous administration of vaccines is defined as administering more than one vaccine on the same clinic day, at different anatomic sites, and not combined in the same syringe. Experimental evidence and extensive clinical experience provide the scientific basis for administering vaccines simultaneously. Simultaneously administering all vaccines for which a person is eligible at the time of the visit increases the probability that a child will be vaccinated fully by the appropriate age. A study conducted during a measles outbreak demonstrated that approximately one third of measles cases among unvaccinated but vaccine-eligible preschool children could have been prevented if MMR had been administered at the same visit when another vaccine was administered. Simultaneous administration also is critical when preparing for foreign travel and when a health-care provider is uncertain that a person will return for additional doses of vaccine.

With some exceptions, simultaneously administering the most widely used live and inactivated vaccines has produced seroconversion rates and rates of adverse reactions similar to those observed when the vaccines are administered separately. Routine administration of all age-appropriate doses of vaccines simultaneously is recommended for children for whom no specific contraindications exist at the time of the visit. MMR and varicella vaccine can be administered simultaneously. Live, attenuated influenza vaccine (LAIV) does not interfere with the immune response to MMR or varicella vaccines administered at the same visit. No data exist about the immunogenicity of oral Ty21a typhoid vaccine when administered concurrently or within 30 days of live virus vaccines. In the absence of such data, if typhoid vaccination is warranted, administration should not be delayed because of recent administration of live, attenuated virus vaccines. Simultaneous administration of pneumococcal polysaccharide vaccine (PPSV) and inactivated influenza vaccine elicits a satisfactory antibody response without increasing the incidence or severity of adverse reactions. Simultaneous administration of PPSV and inactivated influenza vaccine is recommended for all persons for whom both vaccines are indicated. Tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) and trivalent inactivated influenza vaccine (TIV) can be administered simultaneously. Hepatitis B vaccine (HepB) administered with yellow fever vaccine is as safe and immunogenic as when these vaccines are administered separately. Measles and yellow fever vaccines have been administered safely at the same visit and without reduction of immunogenicity of either of the components.

Depending on which vaccines are administered during the first year of life, a child might receive up to nine injections at the 12- through 15-month visit (MMR, varicella, Hib, pneumococcal conjugate vaccine [PCV], DTaP, IPV, HepA, HepB, and influenza vaccines). Although there is no exact limit on the number of injections, with a little flexibility, a provider can ensure that the primary series doses are given without administering too many injections at each visit. To reduce the number of injections at the 12- through 15-month visit, the hepatitis B series and 3 doses of IPV can be administered before the child's first birthday.

There are many other examples of ways the vaccination schedule provides flexibility. The majority of children aged 1 year who have received 2 Hib vaccine doses (polyribosylribitol phosphate-meningococcal outer membrane protein [PRP-OMP]) or 3 Hib vaccine doses (PRP-tetanus [PRP-T]) and 3 previous doses of DTaP and PCV have protection against Hib, diphtheria, pertussis, tetanus, and pneumococcus, which lasts throughout infancy. The third (PRP-OMP) or fourth (PRP-T) dose of the Hib series and the fourth doses of DTaP and PCV are critical in boosting antibody titer and ensuring continued protection. The fourth dose of DTaP is recommended at age 15–18 months but may be administered as early as age 12 months if 6 months have elapsed since the third dose and if there is concern that the child might not return by age 18 months. For infants at low risk for infection with hepatitis B virus (i.e., mother tested negative for hepatitis B surface antigen [HBsAg] at the time of delivery and is not in a high risk group), the hepatitis B series can be completed at any time for children aged 6–18 months. The minimum age for administration of combination vaccines is the oldest minimum age for any of the individual components; the minimum interval between doses is equal to the greatest minimum interval of any of the individual components. With use of the combination Hib-hepatitis B vaccine, the minimum age of administration of the final dose is 12 months because of the minimum age requirement for the last dose of the Hib series. Recommended spacing of doses should be maintained (see Table 1 above).

Combination Vaccines

Combination vaccines merge equivalent component vaccines into single products to prevent more than one disease or to protect against multiple strains of infectious agents causing the same disease. Licensed combination vaccines can be used whenever any components of the combination are indicated and its other components are not contraindicated and if licensed by the Food and Drug Administration (FDA) for that dose in the series. Use of combination vaccines can reduce the number of injections patients receive and alleviate concern associated with the number of injections. Studies have demonstrated that parents and providers might be uncomfortable with multiple injections during single visits. (See the "Potential Benefits" and "Potential Harms" fields for further discussion.)

Licensed Combination Vaccines

Seven combination vaccines for which separate antigens or antigen combinations exist have been licensed by FDA since 1996 in the United States (see Table 2 in the original guideline document).

The use of a combination vaccine generally is preferred over separate injections of the equivalent component vaccines. Considerations should include provider assessment,[§] patient preference, and the potential for adverse events. An exception is the first dose of MMRV. Unless the parent or caregiver expresses a preference for MMRV vaccine, MMR and varicella vaccine should be administered for the first dose for children aged 12–47 months.

[§] Provider assessment should include number of injections, vaccine availability, likelihood of improved coverage, likelihood of patient return, and storage and cost considerations.)

Combination Vaccines and FDA Licensure

Only combination vaccines licensed by FDA should be used. Vaccination providers should not combine separate vaccines into the same syringe to administer together unless mixing is indicated for the patient's age and is explicitly specified on the FDA-approved product label inserts. Only two combination vaccines (DTaP-IPV/Hib vaccine, marketed as Pentacel, and DTaP/Hib, marketed as TriHibit) contain separate antigen components for which FDA approves mixing by the user. The safety, immunogenicity, and effectiveness of unlicensed combinations are unknown.

Extra Doses of Vaccine Antigens

Administering extra antigens contained in a combination vaccine should be avoided in most situations. Using combination vaccines containing certain antigens not indicated at the time of administration to a patient might be justified when 1) the extra antigen is not contraindicated, 2) products that contain only the needed antigens are not readily available, and 3) potential benefits to the patient outweigh the potential risk for adverse events associated with the extra antigens. An extra dose of many live-virus vaccines and Hib or hepatitis B vaccine has not been found to be harmful. However, the risk for an adverse event might increase when extra doses are administered at an earlier time than the recommended interval for certain vaccines (e.g., tetanus toxoid vaccines and PPSV).

A vaccination provider might not have vaccines available that contain only the antigens needed as indicated by a child's vaccination history. Alternatively, although the indicated vaccines might be available, the provider might prefer to use a combination vaccine to reduce the required number of injections. In such cases, the benefits and risks of administering the combination vaccine with an unneeded antigen should be carefully considered and discussed with the patient or parent.

When inactivated (i.e., killed), or particular subunit vaccines (which are often adsorbed to aluminum-salt adjuvants), are administered, the reactogenicity of the vaccine must be considered in balancing the benefits and risks of extra doses. Because clinical experience suggests low reactogenicity, an extra dose of Hib or hepatitis B vaccine may be administered as part of a combination vaccine to complete a vaccination series for another component of the combination. Administration of extra doses of tetanus toxoid vaccines earlier than the recommended intervals can increase the risk for hypersensitivity reactions. Examples of such vaccines include DTaP, DTaP/Hib, DT (for children), Td (for adolescents and adults), and Tdap. Extra doses of tetanus-toxoid–containing vaccines might be appropriate for certain patients, including for children who previously received DT or Td vaccine and need protection from pertussis (in DTaP or Tdap) or for immigrants with uncertain vaccination histories.

Conjugate Vaccine Carrier Proteins

Certain carrier proteins in existing conjugated Hib vaccines also are used as components of other vaccines (e.g., pneumococcal and meningococcal vaccines). Protein conjugates used in Hib conjugate vaccines produced in the United States include an outer membrane protein complex from *Neisseria meningitidis* (in PRP-OMP), and tetanus toxoid (in PRP-T). Simultaneous administration of quadrivalent meningococcal conjugate vaccine (MCV4), PCV, and Tdap, all of which contain diphtheria toxoid, is not associated with reduced immunogenicity or an increase in local adverse events.

See the original guideline document for more information on licensed combination vaccines, interchangeability of formulations and combination vaccines from different manufacturers, and vaccine supply.

Nonsimultaneous Administration

There is no evidence that inactivated vaccines interfere with the immune response to other inactivated vaccines or to live vaccines. Any inactivated vaccine can be administered either simultaneously or at any time before or after a different inactivated vaccine or live vaccine (see Table 3 in the original guideline document).

Limited data are available regarding interference between live vaccines used in the United States. The immune response to one live-virus vaccine might be impaired if administered within 28 days (i.e., 4 weeks) of another live-virus vaccine. The effect of nonsimultaneous administration of rubella, mumps, varicella, and yellow fever vaccines is unknown.

To minimize the potential risk for interference, injectable or nasally administered live vaccines not administered on the same day should be administered ≥4 weeks apart (see Table 3 in the original guideline document). If injectable or nasally administered live vaccines are separated by <4 weeks, the second vaccine administered should not be counted as a valid dose and should be repeated. The repeat dose should be administered ≥4 weeks after the last invalid dose. Oral vaccines (Ty21a typhoid vaccine and rotavirus) can be administered simultaneously or at any interval before or after other live vaccines (injectable or intranasal) if indicated.

Spacing of Vaccines and Antibody-Containing Products

Live Vaccines

Ty21a typhoid, yellow fever, LAIV, zoster, and rotavirus vaccines may be administered at any time before, concurrent with, or after administration

of any immune globulin, hyper-immune globulin, or intravenous immune globulin (IGIV). Blood (e.g., whole blood, packed red blood cells, and plasma) and other antibody-containing blood products (e.g., immune globulin, hyperimmune globulin, and IGIV) can inhibit the immune response to measles and rubella vaccines for ≥3 months. The effect of blood and immune globulin preparations on the response to mumps and varicella vaccines is unknown; however, commercial immune globulin preparations contain antibodies to these viruses. Blood products available in the United States are unlikely to contain a substantial amount of antibody to yellow fever vaccine virus. The length of time that interference with injectable live-virus vaccine (other than yellow fever) can persist after the antibody-containing product is a function of the amount of antigen-specific antibody contained in the product. Therefore, after an antibody-containing product is received, live vaccines (other than yellow fever vaccine, oral Ty21a typhoid, LAIV, zoster, and rotavirus) should be delayed until the passive antibody has degraded (see Table 4 in the original guideline document). If a dose of injectable live-virus vaccine (other than yellow fever and zoster) is administered after an antibody-containing product but at an interval shorter than recommended in this report, the vaccine dose should be repeated unless serologic testing is feasible and indicates a response to the vaccine. The repeat dose or serologic testing should be performed after the interval indicated for the antibody-containing product (see Table 5 in the original guideline document).

Although passively acquired antibodies can interfere with the response to rubella vaccine, the low dose of anti-Rho(D) globulin administered to postpartum women has not been demonstrated to reduce the response to the RA27/3 strain rubella vaccine. Because of the importance of rubella and varicella immunity among women of child-bearing age, the postpartum vaccination of women without evidence of immunity to rubella or varicella with MMR, varicella, or MMRV vaccines should not be delayed because of receipt of anti-Rho(D) globulin or any other blood product during the last trimester of pregnancy or at delivery. These women should be vaccinated immediately after giving birth and, if possible, tested ≥3 months later to ensure immunity to rubella and, if appropriate, to measles.

Interference might occur if administration of an antibody-containing product becomes necessary after administration of MMR or varicella vaccines. Usually, vaccine virus replication and stimulation of immunity occurs 1–2 weeks after vaccination. If the interval between administration of any of these vaccines and subsequent administration of an antibody-containing product is <14 days, vaccination should be repeated after the recommended interval (see Tables 4 and 5 in the original guideline document) unless serologic testing indicates a protective antibody response.

Inactivated Vaccines

Antibody-containing products interact less with inactivated vaccines, toxoids, recombinant subunit, and polysaccharide vaccines than with live vaccines. Therefore, administering inactivated vaccines and toxoids either simultaneously with or at any interval before or after receipt of an antibody-containing product should not substantially impair development of a protective antibody response (see Tables 4 in the original guideline document). The vaccine or toxoid and antibody preparation should be administered at different sites by using the standard recommended dose. Increasing the vaccine dose volume or number of vaccinations is not indicated or recommended.

Interchangeability of Single-Component Vaccines from Different Manufacturers

Certain vaccines that provide protection from the same diseases are available from different manufacturers, and these vaccines usually are not identical in antigen content or amount or method of formulation. Manufacturers use different production processes, and their products might contain different concentrations of antigen per dose or a different stabilizer or preservative.

See the original guideline document for more information about interchangeability of Hib conjugate, HepB, HepA, rotavirus, quadrivalent meningococcal conjugate, and acellular pertussis vaccines from different manufacturers.

Lapsed Vaccination Schedule

Vaccination providers should administer vaccines as close to the recommended intervals as possible. However, intervals between doses that are longer than recommended typically do not reduce final antibody concentrations, although protection might not be attained until the recommended number of doses has been administered. With exception of oral typhoid vaccine, an interruption in the vaccination schedule does not require restarting the entire series of a vaccine or toxoid or addition of extra doses.

Unknown or Uncertain Vaccination Status

Vaccination providers frequently encounter persons who do not have adequate documentation of vaccinations. With the exception of influenza vaccine and PPSV, providers should only accept written, dated records as evidence of vaccination; self-reported doses of influenza vaccine and PPSV are acceptable. Although vaccinations should not be postponed if records cannot be found, an attempt to locate missing records should be made by contacting previous health-care providers, reviewing state or local immunization information systems (IISs), and searching for a personally held record. If records cannot be located within a reasonable time, these persons should be considered susceptible and started on the age-appropriate vaccination schedule. Serologic testing for immunity is an alternative to vaccination for certain antigens (e.g., measles, rubella, hepatitis A, and tetanus).

Contraindications and Precautions

Contraindications and precautions to vaccination are conditions under which vaccines should not or likely should not be administered. Because the majority of contraindications and precautions are temporary, vaccinations often can be administered later if one or more exist. A contraindication is a condition in a recipient that increases the risk for a serious adverse reaction. A vaccine should not be administered when a contraindication is present; for example, MMR vaccine should not be administered to severely immunocompromised persons. In contrast, certain conditions are commonly misperceived as contraindications (i.e., are not valid reasons to defer vaccination).

National standards for pediatric vaccination practices have been established and include descriptions of valid contraindications and precautions to vaccination. Persons who administer vaccines should screen patients for contraindications and precautions to the vaccine before each dose of vaccine is administered (see Table 6 in the original guideline document). Screening is facilitated by consistent use of screening questionnaires, which are available from certain state vaccination programs and other sources (e.g., the Immunization Action Coalition).

The only contraindication applicable to all vaccines is a history of a severe allergic reaction (i.e., anaphylaxis) after a previous dose of vaccine or to a vaccine component (unless the recipient has been desensitized; see the Special Situations section of the original guideline document). In addition, severely immunocompromised persons should generally not receive live vaccines. Children who experience encephalopathy within 7 days after administration of a previous dose of diphtheria and tetanus toxoids and whole-cell pertussis vaccine (DTP), DTaP, or Tdap not attributable to another identifiable cause should not receive additional doses of a vaccine that contains pertussis. Because of the theoretical risk for the fetus, women known to be pregnant generally should not receive live, attenuated virus vaccines (see "Special Situations" section below).

A precaution is a condition in a recipient that might increase the risk for a serious adverse reaction or that might compromise the ability of the vaccine to produce immunity (e.g., administering measles vaccine to a person with passive immunity to measles from a blood transfusion or administering influenza vaccine to someone with a history of Guillain-Barré syndrome within 6 weeks of a previous influenza vaccination). A person might experience a more severe reaction to the vaccine than would have otherwise been expected; however, the risk for this happening is less than the risk expected with a contraindication. In general, vaccinations should be deferred when a precaution is present. However, a vaccination might be indicated in the presence of a precaution if the benefit of protection from the vaccine outweighs the risk for an adverse reaction. For example a dose of DTaP should be considered for a person in a community with a pertussis outbreak even if that person previously developed Guillain-Barré syndrome after a dose.

The presence of a moderate or severe acute illness with or without a fever is a precaution to administration of all vaccines (see Table 6 in the original guideline document). A personal or family history of seizures is a precaution for MMRV vaccination. A recent study found an increased risk for febrile seizures in children who receive MMRV compared with MMR and varicella vaccine.

See the original guideline document for further information about contraindications and precautions to vaccination.

Preventing and Managing Adverse Reactions

Benefit and Risk Communication

Parents, guardians, legal representatives, and adolescent and adult patients should be informed about the benefits of and risks from vaccines in language that is culturally sensitive and at an appropriate educational level. Opportunity for questions should be provided before each vaccination. Discussion of the benefits of and risks from vaccination is sound medical practice and is required by law. See the original guideline document for further discussion.

Preventing Adverse Reactions

Vaccines are intended to produce active immunity to specific antigens. An adverse reaction is an undesirable side effect that occurs after a vaccination. Vaccine adverse reactions are classified as 1) local, 2) systemic, or 3) allergic (additional information is available at http://www.fda.gov). Local reactions (e.g., redness) are usually the least severe and most frequent. Systemic reactions (e.g., fever) occur less frequently than local reactions, and severe allergic reactions (e.g., anaphylaxis) are the least frequent reactions. Severe adverse reactions are rare.

Syncope (vasovagal or vasodepressor reaction) can occur after vaccination and is most common among adolescents and young adults. In 2005, the Vaccine Adverse Event Reporting System (VAERS) began detecting a trend of increasing syncope reports that coincided with the licensure of three vaccines for adolescents: human papillomavirus (HPV), MCV4, and Tdap. Of particular concern among adolescents has been the risk for serious secondary injuries, including skull fracture and cerebral hemorrhage.

Providers should take appropriate measures to prevent injuries if a patient becomes weak or dizzy or loses consciousness. Adolescents and adults should be seated or lying down during vaccination. Vaccine providers, particularly when vaccinating adolescents, should consider observing

patients (with patients seated or lying down) for 15 minutes after vaccination to decrease the risk for injury should they faint. If syncope develops, patients should be observed until the symptoms resolve.

Managing Acute Vaccine Reactions

Although anaphylactic reactions are rare after vaccination, their immediate onset and life-threatening nature require that all personnel and facilities providing vaccinations have procedures in place for anaphylaxis management. All vaccination providers should be familiar with the office emergency plan and be currently certified in cardiopulmonary resuscitation. Epinephrine and equipment for maintaining an airway should be available for immediate use.

Anaphylaxis usually begins within minutes of vaccine administration. Rapid recognition and initiation of treatment are required to prevent possible progression to cardiovascular collapse. If flushing, facial edema, urticaria, itching, swelling of the mouth or throat, wheezing, dyspnea, or other signs or symptoms of anaphylaxis occur, the patient should be placed in a recumbent position with the legs elevated if possible. Administration of epinephrine is the management of choice. Additional drugs also might be indicated (see Table 8 in the original guideline document). Maintenance of the airway and oxygen administration might be necessary. After the patient is stabilized, arrangements should be made for immediate transfer to an emergency facility for additional evaluation and treatment.

Reporting Adverse Events After Vaccination

The National Childhood Vaccine Injury Act requires health-care providers and vaccine manufacturers to report to the Vaccine Adverse Event Reporting System (VAERS) specific adverse events that occur after vaccination. The reporting requirements are different for manufacturers and health-care providers. Manufacturers are required to report all adverse events that occur after vaccination to VAERS, whereas health-care providers are required to report events that appear in the reportable events table on the VAERS Web site .

In addition to the mandated reporting of events listed on the reportable events table, health-care providers should report to VAERS all events listed in product inserts as contraindications, as well as all clinically significant adverse events, even if they are uncertain that the adverse event is related causally to vaccination. Persons other than health-care providers also can report adverse events to VAERS.

See the original guideline document for all three ways to report to VAERS and for information about the National Vaccine Injury Compensation Program.

Vaccine Administration

Infection Control and Sterile Technique

General Precautions

Persons administering vaccinations should follow appropriate precautions to minimize risk for spread of disease. Hands should be cleansed with an alcohol-based waterless antiseptic hand rub or washed with soap and water before preparing the vaccine and between each patient contact. Occupational Safety and Health Administration (OSHA) regulations do not require gloves to be worn when administering vaccinations, unless persons administering vaccinations are likely to come into contact with potentially infectious body fluids or have open lesions on their hands. If gloves are worn, they should be changed between patients.

Needles and Syringes

Needles and syringes used for vaccine injections must be sterile and disposable. A separate needle and syringe should be used for each injection. Changing needles between drawing vaccine from a vial and injecting it into a recipient is not necessary unless the needle has been damaged or contaminated. Different vaccines should never be mixed in the same syringe unless specifically licensed for such use, and no attempt should be made to transfer between syringes. Single-dose vials and manufacturer-filled syringes are designed for single-dose administration and should be discarded if vaccine has been withdrawn or reconstituted and subsequently not used within the time frame specified by the manufacturer. This typically is no longer than the same clinic day (typically recommended as a maximum for inactivated vaccines).

Sometimes providers prefill syringes themselves. ACIP discourages the routine practice of prefilling syringes because of the potential for administration errors and vaccine wastage. Because the majority of vaccines have a similar appearance after being drawn into a syringe, prefilling might result in administration errors. In certain circumstances in which a single vaccine type is being used (e.g., in preparation for a community influenza vaccination campaign), filling a small number of syringes may be considered. Vaccine doses should not be drawn into a syringe until immediately before administration. When syringes are filled, the type of vaccine, lot number, and date of filling must be labeled on each syringe, and the doses should be administered as soon as possible after filling. Unused syringes filled by the end user (i.e., not filled by the manufacturer) should be discarded at the end of the vaccination session. In addition to administration errors, prefilling of syringes is a concern because FDA does not

license administration syringes for vaccine storage. Unused syringes that are prefilled by the manufacturer and activated (i.e., syringe cap removed or needle attached) should be discarded at the end of the clinic day. When in doubt about the appropriate handling of a vaccine, vaccination providers should contact the manufacturer.

Bloodborne diseases (e.g., hepatitis B, hepatitis C, and human immunodeficiency virus [HIV]) are occupational hazards for clinicians and other health-care providers. The Needlestick Safety and Prevention Act was enacted in 2000 to reduce the incidence of needle-stick injury and the consequent risk for bloodborne diseases acquired from patients. These federal regulations require that safety-engineered injection devices (e.g., needle-shielding syringes or needle-free injectors) be used for injectable vaccination in all clinical settings. The regulations also require maintenance of records documenting injuries caused by needles and other medical sharp objects and that nonmanagerial employees be involved in the evaluation and selection of safety-engineered devices before they are procured.

Safety-engineered needles and syringes or needle-free injection devices are preferred and should be encouraged to reduce risk for injury. To prevent inadvertent needle-stick injury or reuse, safety mechanisms should be deployed after use and needles and syringes should be discarded immediately in labeled, puncture-proof containers located in the same room where the vaccine is administered. Used needles should never be recapped.

Needle-shielding or needle-free devices that might satisfy the occupational safety regulations for administering injectable vaccines are available in the United States. Additional information about implementation and enforcement of these regulations is available from OSHA .

Route of Administration

Oral Route

Rotavirus and oral typhoid vaccines are the only vaccines administered orally in the United States. Oral typhoid capsules should be administered as directed by the manufacturer. The capsules should not be opened or mixed with any other substance. Rotavirus vaccines are licensed for infants. There are two brands of rotavirus vaccine, and they have different types of applicators. Providers should consult the package insert for details. A dose of rotavirus vaccine need not be repeated if the vaccine is spit up or vomited. The infant should receive the remaining recommended doses of rotavirus vaccine following the routine schedule.

Intranasal Route

LAIV is licensed for healthy nonpregnant persons aged 2–49 years and is the only vaccine administered by the intranasal route. The administration device is a nasal sprayer with a dose-divider clip that allows introduction of one 0.1-mL spray into each naris. The tip should be inserted slightly into the naris before administration. Even if the person coughs or sneezes immediately after administration or the dose is expelled any other way, the vaccine dose need not be repeated. Introduction of low levels of vaccine viruses into the environment likely is unavoidable when administering LAIV; however, no instances have been reported of illness or attenuated vaccine virus infections among inadvertently exposed health-care providers or immunocompromised patients. The risk for acquiring vaccine viruses from the environment is unknown but is likely low; in addition, vaccine viruses are cold-adapted and attenuated and unlikely to cause symptomatic influenza. Severely immunosuppressed persons should not administer LAIV. However, other persons at higher risk for influenza complications can administer LAIV. These include persons with underlying medical conditions placing them at higher risk or who are likely to be at risk, including pregnant women, persons with asthma, and persons aged ≥50 years.

Intramuscular Injections

Needle Length

Injectable immunobiologics should be administered where local, neural, vascular, or tissue injury is unlikely. Use of longer needles has been associated with less redness or swelling than occurs with shorter needles because of injection into deeper muscle mass. Appropriate needle length depends on age and body mass.

For all intramuscular injections, the needle should be long enough to reach the muscle mass and prevent vaccine from seeping into subcutaneous tissue, but not so long as to involve underlying nerves, blood vessels, or bone. Vaccinators should be familiar with the anatomy of the area into which they are injecting vaccine. Intramuscular injections are administered at a 90-degree angle to the skin, preferably into the anterolateral aspect of the thigh or the deltoid muscle of the upper arm, depending on the age of the patient (see Table 10 in the original guideline document).

A decision on needle size and site of injection must be made for each person on the basis of the size of the muscle, the thickness of adipose tissue at the injection site, the volume of material to be administered, injection technique, and the depth below the muscle surface into which the material is to be injected (see Figure 1 in the original guideline document). Aspiration before injection of vaccines or toxoids (i.e., pulling back on the

syringe plunger after needle insertion but before injection) is not necessary because no large blood vessels are present at the recommended injection sites, and a process that includes aspiration might be more painful for infants.

See the original guideline document for specific recommendations on injection location and needle size for infants (aged <12 months), toddlers (aged 12 months-2 years), children (aged 3-18 years), and adults (aged ≥19 years).

Subcutaneous Injections

Subcutaneous injections are administered at a 45-degree angle usually into the thigh for infants aged <12 months and in the upper-outer triceps area of persons aged ≥12 months. Subcutaneous injections may be administered into the upper-outer triceps area of an infant if necessary. A 5/8-inch, 23- to 25-gauge needle should be inserted into the subcutaneous tissue (see Figures 4 and 5 in the original guideline document).

Multiple Injections

If multiple vaccines are administered at a single visit, administer each preparation at a different anatomic site. For infants and younger children, if more than two vaccines are injected in a single limb, the thigh is the preferred site because of the greater muscle mass; the injections should be sufficiently separated (i.e., ≥1 inch if possible) so that any local reactions can be differentiated. For older children and adults, the deltoid muscle can be used for more than one intramuscular injection. If a vaccine and an immune globulin preparation are administered simultaneously (e.g., Td/Tdap and tetanus immune globulin [TIG], HepB and hepatitis B immunoglobulin [HBIG]), separate anatomic sites should be used for each injection. The location of each injection should be documented in the patient's medical record. Health-care practices should consider using a vaccination site map so that all persons administering vaccines routinely use a particular anatomic site for each different vaccine.

Jet Injections

Jet injectors are needle-free devices that pressurize liquid medication through a nozzle orifice into a narrow stream capable of penetrating skin to deliver a drug or vaccine into intradermal, subcutaneous, or intramuscular tissues. Jet injectors prevent needle-stick injuries to health-care providers and can overcome improper, unsterile reuse and other drawbacks of needles and syringes in developing countries. Immune responses generated by jet injectors against both attenuated and inactivated viral and bacterial antigens are usually equivalent to, and occasionally greater than, immune responses induced by needle injection. However, local reactions or injuries are sometimes more frequent on delivery of vaccine by jet injectors compared with needle injection, depending on the inherent irritability of the vaccine and operator technique. Jet injectors that use the same nozzle for consecutive injections without intervening sterilization were used in mass vaccination campaigns from the 1950s through the 1990s; however, these were found to be unsafe because of the possibility of bloodborne pathogen transmission and should not be used. A new generation of jet injectors with disposable cartridges and syringes have been developed since the 1990s. With a new, sterile dose chamber and nozzle for each patient and correct use, these devices do not have the same safety concerns as multiple-use nozzle jet injectors. Several of the newer devices have been approved by FDA for sale in the United States.

Methods for Alleviating Discomfort and Pain Associated with Vaccination

Comfort measures, such as distraction (e.g., playing music or pretending to blow away the pain) ingestion of sweet liquids, breast feeding, cooling of the injection site, and topical analgesia, can help infants or children cope with the discomfort associated with vaccination. Pretreatment (30–60 minutes before injection) with 5% topical lidocaine-prilocaine emulsion can decrease the pain of vaccination by causing superficial anesthesia. Evidence indicates that this cream does not interfère with the immune response to MMR. Topical lidocaine-prilocaine emulsion should not be used on infants aged <12 months who are receiving treatment with methemoglobin-inducing agents because of the possible development of methemoglobinemia. Use of a topical refrigerant (vapocoolant) spray immediately before vaccination can reduce the short-term pain associated with injections and can be as effective as lidocaine-prilocaine cream. Evidence does not support use of antipyretics before or at the time of vaccination; however, they can be used for the treatment of fever and local discomfort that might occur following vaccination. Studies of children with previous febrile seizures have not demonstrated antipyretics to be effective in the prevention of febrile seizures.

Nonstandard Vaccination Practices

Recommendations for route, site, and dosage of immunobiologics are derived from data from clinical trials, practical experience, normal periodicity of health-care visits, and theoretical considerations. ACIP discourages variations from the recommended route, site, volume, or number of doses of any vaccine.

See the original guideline document for further discussion of nonstandard vaccination practices.

Storage and Handling of Immunobiologics

Failure to adhere to recommended specifications for storage and handling of immunobiologics can reduce or destroy their potency, resulting in

inadequate or no immune response in the recipient. Recommendations in the product package inserts, including methods for reconstitution of the vaccine, should be followed carefully. Maintenance of vaccine quality is the shared responsibility of all handlers of vaccines from the time the vaccine is manufactured until administration. All vaccines should be inspected on delivery and monitored during storage to ensure that the recommended storage temperatures are maintained. Vaccines should continue to be stored at recommended temperatures immediately upon receipt until use. Inadequate vaccine storage also can result in the loss of thousands of dollars worth of vaccine inventory and the cost of inventory replacement.

For further information on storage and handling of immunobiologics, including storage temperature, storage units, temperature monitoring, response to out-of-range temperature reading, expiration dates and windows, and multidose vials, see the original guideline document.

Altered Immunocompetence

General Principles

Altered immunocompetence, a term often used synonymously with immunosuppression and immunocompromise, can be classified as primary or secondary. Primary immunodeficiencies generally are inherited and include conditions defined by an absence or quantitative deficiency of cellular or humoral components or both that provide immunity. Examples include congenital immunodeficiency diseases such as X-linked agammaglobulinemia, severe combined immunodeficiency disease, and chronic granulomatous disease. Secondary immunodeficiency generally is acquired and is defined by loss or qualitative deficiency in cellular and humoral immune components that occurs as a result of a disease process or its therapy. Examples of secondary immune deficiency include human immunodeficiency virus (HIV) infection, hematopoietic malignancies, treatment with radiation, and treatment with immunosuppressive drugs including alkylating agents and antimetabolites. The degree to which immunosuppressive drugs cause clinically significant immunodeficiency generally is dose-related and varies by drug. Primary and secondary immunodeficiencies might include a combination of deficits in both cellular and humoral immunity. In this report, the general term altered immunocompetence also is used to include conditions such as asplenia and chronic renal disease, and treatments with therapeutic monoclonal antibodies (specifically the tumor-necrosis-factor inhibitors) and prolonged administration of high-dose corticosteroids.

Determination of altered immunocompetence is important to the vaccine provider because the incidence or severity of some vaccine-preventable diseases is higher in persons with altered immunocompetence; therefore, certain vaccines (e.g., inactivated influenza vaccine and pneumococcal vaccines) are recommended specifically for persons with these diseases. Vaccines might be less effective during the period of altered immunocompetence. Live vaccines might need to be deferred until immune function has improved. Inactivated vaccines administered during the period of altered immunocompetence might need to be repeated after immune function has improved. In addition, persons with altered immunocompetence might be at increased risk for an adverse reaction after administration of live, attenuated vaccines because of uninhibited replication.

The degree of altered immunocompetence in a patient should be determined by a physician. The challenge for clinicians and other health-care providers is in assessing the safety and effectiveness of vaccines for conditions associated with primary or secondary immunodeficiency, especially when new therapeutic modalities are being used and information about the safety and effectiveness of vaccines has not been characterized fully in persons receiving these drugs (see Table 13 in the original guideline document). Laboratory studies can be useful for assessing the effects of a disease or drug on the immune system. Tests useful to assess humoral immunity include immunoglobulin (and immunoglobulin subset) levels and specific antibody levels (e.g., tetanus and diphtheria). Tests that demonstrate the status of cellular immunity include lymphocyte numbers (i.e., a complete blood count with differential), a test that delineates concentrations and proportions of lymphocyte subsets (i.e., B and T lymphocytes, CD4+ T versus CD8+ T lymphocytes), and tests that measure T-cell proliferation in response to specific or nonspecific stimuli (e.g., lymphocyte proliferation assays). The ability to characterize a drug or disease condition as affecting cellular or humoral immunity is only the first step; using this information to draw inferences about whether particular vaccines are indicated or whether caution is advised with use of live or inactivated vaccines is more complicated and might require consultation with an infectious disease or immunology specialist.

Altered Immunocompetence as an Indication to Receive a Vaccine

Persons with altered immunocompetence generally are advised to receive TIV and age-appropriate polysaccharide-based vaccines (i.e., PCV, PPSV, MCV4, MPSV4, and Hib) on the basis of demonstrated effectiveness and an increased risk for disease if the vaccine is withheld.

See the original guideline document for specific recommendations about pneumococcal, influenza, meningococcal, and Hib vaccines in persons with altered immunocompetence, as well as information about vaccination of contacts of persons with altered immunocompetence, vaccination with inactivated vaccines, vaccination with live, attenuated vaccines, vaccination of recipients of hematopoietic stem cell transplants, and situations in which conditions or drugs might cause immunodeficiencies.

Special Situations

Concurrent Administration of Antimicrobial Agents and Vaccines

With a few exceptions, use of an antimicrobial agent is not a contraindication to vaccination. Antibacterial agents have no effect on the response to live, attenuated vaccines, except live oral Ty21a typhoid vaccine, and have no effect on inactivated, recombinant subunit, or polysaccharide vaccines or toxoids. Ty21a typhoid vaccine should not be administered to persons receiving antimicrobial agents until 72 hours after the last dose of antimicrobial. If feasible, to avoid a possible reduction in vaccine effectiveness, antibacterial drugs should not be started or resumed until 1 week after the last dose of Ty21a.

Antiviral drugs used for treatment or prophylaxis of influenza virus infections have no effect on the response to inactivated influenza vaccine. However, live, attenuated influenza vaccine should not be administered until 48 hours after cessation of therapy with antiviral influenza drugs. If feasible, to avoid possible reduction in vaccine effectiveness, antiviral medication should not be administered for 14 days after LAIV administration. Antiviral drugs active against herpesviruses (e.g., acyclovir or valacyclovir) might reduce the efficacy of live, attenuated varicella or zoster vaccine. These drugs should be discontinued at least 24 hours before administration of vaccines containing varicella zoster virus, including zoster vaccine, if possible. Delay use or resumption of antiviral therapy for 14 days after vaccination. No data exist to suggest that commonly used antiviral drugs have an effect on rotavirus vaccine or MMR.

Tuberculosis Screening and Skin Test Reactivity

Measles illness, severe acute or chronic infections, HIV infection, and malnutrition can create a relatively anergic state during which the tuberculin skin test (TST) might give a false-negative reaction. Although any live, attenuated measles vaccine theoretically can suppress TST reactivity, the degree of suppression is likely less than that occurring from acute infection from wild-type measles virus. Although routine TST screening of all children is no longer recommended, TST screening is sometimes needed (e.g., for well child care, school entrance, or employee health reasons) at the same time as administration of a measles-containing vaccine.

The TST and measles-containing vaccine can be administered at the same visit (preferred option). Simultaneously administering TST and measles-containing vaccine does not interfere with reading the TST result at 48-72 hours and ensures that the person has received measles vaccine.

If the measles-containing vaccine has been administered recently, TST screening should be delayed for at least 4 weeks after vaccination. A delay in performing TST will remove the concern of any theoretical but transient suppression of TST reactivity from the vaccine.

TST screening can be performed and read before administering the measles-containing vaccine. This option is the least favored because it delays receipt of the measles-containing vaccine. If a person is suspected to have tuberculosis, not only should the MMR vaccine be withheld before the TST, it should be withheld until after treatment has been initiated because a person with active tuberculosis who is moderately or severely ill should not receive MMR vaccine. In a general screening situation in which tuberculosis is not suspected, a TST may be administered simultaneously with live vaccines or should be deferred for 28 days after vaccination.

No data exist regarding the potential degree of TST suppression that might be associated with other injectable live, attenuated virus vaccines (e.g., varicella or yellow fever). However, in the absence of data, following guidelines for measles-containing vaccine when scheduling TST screening and administering other live, attenuated virus vaccines is prudent. If the opportunity to vaccinate might be missed, vaccination should not be delayed only because of these theoretical considerations. Because of similar concerns about smallpox vaccine and TST suppression, a TST should not be performed until 4 weeks after smallpox vaccination.

The interferon-gamma release assay (IGRA) requires only one visit to complete and is less sensitive to the effects of previous bacille Calmette-Guerin (BCG) vaccination. The same timing guidelines that apply to the interval between a live vaccine and TST apply to IGRA (i.e., 28 days between live vaccine and IGRA if they do not occur on the same day), because IGRA (like TST) might be suppressed through immunologic mechanisms.

The potential for TST to cause boosting of results should be considered in adults who might have latent tuberculosis and have a negative initial TST. The two-step tuberculin test is recommended for certain situations. Because this test consists of two TSTs (or a TST followed by IGRA) separated by an interval of 1 to 3 weeks, there is a greater window of time during which live vaccine replication could suppress reactivity. If a live vaccine is administered, the first dose of a two-step TST should be delayed for 4 weeks, and if additional doses of live vaccines are indicated thereafter, they should be delayed until the second TST (or the IGRA after an initial TST).

TST or IGRA reactivity in the absence of tuberculosis disease is not a contraindication to administration of any vaccine, including live, attenuated virus vaccines. Tuberculosis disease is not a contraindication to vaccination, unless the person is moderately or severely ill. Although no studies have reported the effects of MMR vaccine on persons with untreated tuberculosis, a theoretical basis exists for concern that measles vaccine might exacerbate tuberculosis disease. As a result, before administering MMR to persons with untreated active tuberculosis, initiating antituberculosis therapy is advisable. Considering whether concurrent immunosuppression (e.g., immunosuppression caused by HIV infection) is a concern before

administering live, attenuated vaccines also is prudent.

Severe Allergy to Vaccine Components

Vaccine components can cause allergic reactions among certain recipients. These reactions can be local or systemic and can include anaphylaxis or anaphylactic-like responses (e.g., generalized urticaria or hives, wheezing, swelling of the mouth and throat, dyspnea, hypotension, and shock). Allergic reactions might be caused by the vaccine antigen, residual animal protein, antimicrobial agents, preservatives, stabilizers, or other vaccine components. Children who have had an apparent severe allergic reaction to a vaccine should be evaluated by an allergist to determine the responsible allergen and to make recommendations regarding future vaccination. Components of each vaccine are listed in the perspective package insert. An extensive list of vaccine components and their use, as well as the vaccines that contain each component has been published and is also available from the CDC Web site .

See the original guideline document for a discussion of some of the common vaccine components and potential allergic reactions.

Latex Allergy

The most common type of latex sensitivity is a contact-type (type 4) allergy, usually as a result of prolonged contact with latex-containing gloves. However, latex allergies associated with injection procedures have been described among patients with diabetes mellitus. Allergic reactions (including anaphylaxis) after vaccinations are rare.

If a person reports a severe (anaphylactic) allergy to latex, vaccines supplied in vials or syringes that contain natural rubber latex should not be administered unless the benefit of vaccination clearly outweighs the risk for a potential allergic reaction. In these cases, providers should be prepared to treat patients who are having an allergic reaction. For latex allergies other than anaphylactic allergies (e.g., a history of contact allergy to latex gloves), vaccines supplied in vials or syringes that contain dry, natural rubber or natural rubber latex may be administered.

Vaccination of Preterm Infants

In the majority of cases, preterm infants (infants born before 37 weeks' gestation), regardless of birth weight, should be vaccinated at the same chronological age and according to the same schedule and using the same precautions as for full-term infants and children. Birth weight and size are not factors in deciding whether to vaccinate a clinically stable preterm infant, except for HepB vaccination. The full recommended dose of each vaccine should be used. Divided or reduced doses are not recommended.

Decreased seroconversion rates might occur among certain preterm infants (i.e., with low birth weights [<2,000 g]) after administration of HepB vaccine at birth. However, by the chronological age of 1 month, all preterm infants, regardless of initial birth weight, are likely to respond as adequately as larger infants. Preterm infants born to hepatitis B surface antigen (HBsAg)-positive mothers and mothers with unknown HBsAg status must receive immunoprophylaxis with HepB vaccine within 12 hours after birth. The initial vaccine dose should not be counted toward completion of the hepatitis B series, and 3 additional doses of HepB vaccine should be administered, beginning when the infant is aged 1 month. For mothers with unknown HBsAg status, attempts should be made to determine HBsAg status. The infant must be given HBIG within 12 hours of birth unless the mother is found to be HBsAg negative. Infants weighing <2,000 g born to HBsAg-negative mothers should receive the first dose of the hepatitis B series at chronological age 1 month or at hospital discharge.

If a child aged at least 6 weeks has been in the hospital since birth, deferral of rotavirus vaccine is recommended until the time of discharge. The rotavirus vaccine series should not be initiated for infants aged ≥15 weeks, 0 days.

Breastfeeding and Vaccination

Neither inactivated nor live-virus vaccines administered to a lactating woman affect the safety of breast feeding for women or their infants. Although live viruses in vaccines can replicate in vaccine recipients (i.e., the mother), the majority of live viruses in vaccines have been demonstrated not to be excreted in human milk. Varicella vaccine virus has not been found in human milk. Although rubella vaccine virus might be excreted in human milk, the virus usually does not infect the infant. If infection does occur, it is well tolerated because the virus is attenuated. Inactivated, recombinant, subunit, polysaccharide, and conjugate vaccines, as well as toxoids, pose no risk for mothers who are breastfeeding or for their infants. Breastfeeding is a contraindication for smallpox vaccination of the mother because of the theoretical risk for contact transmission from mother to infant. Yellow fever vaccine should be avoided in breastfeeding women. However, when nursing mothers cannot avoid or postpone travel to areas endemic for yellow fever in which risk for acquisition is high, these women should be vaccinated.

Limited data indicate that breastfeeding can enhance the response to certain vaccine antigens. There are no data to suggest that passive transfer of antibodies in human milk can affect the efficacy of live-virus vaccines. Breastfed infants should be vaccinated according to the recommended schedule.

Vaccination During Pregnancy

Risk to a developing fetus from vaccination of the mother during pregnancy is theoretical. No evidence exists of risk from vaccinating pregnant women with inactivated virus or bacterial vaccines or toxoids. Live vaccines administered to a pregnant woman pose a theoretical risk to the fetus; therefore, live, attenuated virus and live bacterial vaccines generally are contraindicated during pregnancy. Benefits of vaccinating pregnant women usually outweigh potential risks when the likelihood of disease exposure is high, when infection would pose a risk to the mother or fetus, and when the vaccine is unlikely to cause harm.

See the original guideline document for specific recommendations for vaccination during pregnancy.

Persons Vaccinated Outside the United States

Clinicians have a limited ability to determine whether persons are protected on the basis of their country of origin and their records alone. Vaccines administered outside the United States can generally be accepted as valid if the schedule (i.e., minimum ages and intervals) is similar to that recommended in the United States. With the exception of the influenza vaccine and PPSV, only written documentation should be accepted as evidence of previous vaccination. Written records are more likely to predict protection if the vaccines, dates of administration, intervals between doses, and age at the time of vaccination are comparable to U.S. recommendations. Although vaccines with inadequate potency have been produced in other countries, the majority of vaccines used worldwide are produced with adequate quality control standards and are potent.

The number of U.S. families adopting children from outside the United States has increased substantially in the last decade. Adopted children's birth countries often have vaccination schedules that differ from the recommended childhood immunization schedule in the United States. Differences in the U.S. schedule and those used in other countries include the vaccines administered, the recommended ages of administration, and the number and timing of doses.

Data are inconclusive regarding the extent to which an internationally adopted child's immunization record reflects the child's protection. A child's record might indicate administration of MMR vaccine when only single-antigen measles vaccine was administered.

Health-care providers should ensure that household contacts of international adoptees are vaccinated adequately, particularly for measles, hepatitis A, and hepatitis B.

Health-care providers may use one of multiple approaches if the immunogenicity of vaccines administered to persons outside the United States is in question. Repeating the vaccinations is an acceptable option that is usually safe and prevents the need to obtain and interpret serologic tests. If avoiding unnecessary injections is desired, judicious use of serologic testing might help determine which vaccinations are needed. For some vaccines, the most readily available serologic tests cannot document protection against infection. See the original guideline document and Table 14 in the original guideline document for guidance on possible approaches to evaluation and revaccination for each vaccine recommended in the United States, including the following vaccines: DTaP, HepA, HepB, Hib, MMR, PCV and PPSV, IPV, rotavirus, Td and Tdap, varicella, and zoster.

Vaccinating Persons with Bleeding Disorders

Because of the risk for hematoma formation after injections, intramuscular injections are often avoided among persons with bleeding disorders by using the subcutaneous or intradermal routes for vaccines that normally are administered intramuscularly.

When HepB or any other intramuscularly administered vaccine is indicated for a patient with a bleeding disorder, the vaccine should be administered intramuscularly if a physician familiar with the patient's bleeding risk determines that the vaccine can be administered by this route with reasonable safety. If the patient receives antihemophilia or similar therapy, intramuscularly administered vaccinations can be scheduled shortly after such therapy is administered. A fine-gauge needle (23 gauge or smaller caliber) should be used for the vaccination, followed by firm pressure on the site, without rubbing, for at least 2 minutes. The patient or family should be given information on the risk for hematoma from the injection. Patients receiving anticoagulation therapy presumably have the same bleeding risk as patients with clotting factor disorders and should follow the same guidelines for intramuscular administration.

Vaccination Records

See the original guideline document for maintaining records of health-care providers and personal records for patients and the use of immunization information systems. The guideline also provides resources for vaccination programs and updated vaccine information.

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Vaccine-preventable diseases, including the following:

- Diphtheria
- *Haemophilus influenzae* type b infection
- Hepatitis A and B
- Herpes zoster
- Human papillomavirus (HPV) infection
- Influenza
- Measles
- Meningococcal disease
- Mumps
- Pertussis
- Pneumococcal infection
- Polio
- Rotavirus infection
- Rubella
- Tetanus
- Tuberculosis
- Typhus
- Varicella (chickenpox)
- Yellow fever

Guideline Category

Prevention

Risk Assessment

Clinical Specialty

Family Practice

Infectious Diseases

Internal Medicine

Pediatrics

Preventive Medicine

Intended Users

Advanced Practice Nurses

Health Care Providers

Nurses

Physician Assistants

Physicians

Public Health Departments

Guideline Objective(s)

- To provide updated recommendations to the 2006 statement by the Advisory Committee on Immunization Practices (ACIP)
- To help vaccination providers in the United States to assess vaccine benefits and risks, use recommended administration and storage practices, understand the most effective strategies for ensuring that vaccination coverage in the population remains high, and communicate the importance of vaccination to reduce the effects of vaccine-preventable disease.

Target Population

Infants, children, adolescents, and adults

Interventions and Practices Considered

Immunization Practices

1. Timing and spacing of immunobiologics, including the following considerations:
    - Vaccine scheduling
    - Spacing of multiple doses of the same antigen
    - Simultaneous administration of vaccines
    - Administration of combination vaccines
    - Nonsimultaneous administration of vaccines
    - Spacing of antibody-containing products and vaccines
    - Interchangeability of single-component vaccines from different manufacturers
    - Managing lapsed vaccination schedules
    - Managing unknown or uncertain vaccination status
2. Recognizing true and untrue contraindications and precautions to vaccine administration
3. Preventing and managing adverse events, including the following considerations:
    - Benefit and risk communication
    - Managing acute vaccine reactions
    - Reporting adverse events after vaccination
    - Access to the National Vaccine Injury Compensation Program
4. Vaccine administration
    - Infection control and sterile technique
    - Route of administration (oral, intranasal, intramuscular, subcutaneous)
    - Methods for alleviating discomfort and pain associated with vaccination
5. Storing and handling of immunobiologics
6. Managing special situations
    - Persons with altered immunocompetence and their contact persons
    - Concurrent administration of antimicrobial agents and vaccines
    - Tuberculosis screening and skin test reactivity
    - Severe allergy to vaccine components
    - Latex allergy
    - Vaccination of preterm infants
    - Vaccination during breast-feeding
    - Vaccination during pregnancy
    - Persons vaccinated outside the United States
    - Vaccinating persons with bleeding disorders and persons receiving anticoagulant therapy

7. Adhering to standard vaccination programs, maintaining vaccination records, and reporting adverse events after vaccination

Major Outcomes Considered

- Seroconversion rates
- Adverse effects (morbidity and mortality) of vaccines

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Not stated

Number of Source Documents

Not stated

Methods Used to Assess the Quality and Strength of the Evidence

Not stated

Rating Scheme for the Strength of the Evidence

Not applicable

Methods Used to Analyze the Evidence

Review

Description of the Methods Used to Analyze the Evidence

Not stated

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

The Advisory Committee on Immunization Practices (ACIP) General Recommendations Work Group (GRWG) revises the General Recommendations on Immunization every 3 to 5 years. Relevant topics are those identified by ACIP as topics that relate to all vaccines, including timing and spacing of doses, vaccine administration, and vaccine storage and handling. New topics often are added when ACIP decides that previous ACIP statements on general issues such as combination vaccines, adolescent vaccination, or adult vaccination should be revised and

combined with the *General Recommendations on Immunization*.

The recommendations in this report are based not only on available scientific evidence but also on expertise that comes directly from a diverse group of health-care providers and public health officials. The GRWG includes professionals from academic medicine (pediatrics, family practice, and pharmacy); international (Canada), federal, and state public health professionals; and a member from the nongovernmental Immunization Action Coalition. GRWG, which met monthly beginning June 2007, formed subgroups on the basis of interest in topics such as timing and spacing, vaccine administration, and storage and handling. These subgroups also met monthly, conducted literature reviews, and contributed expert opinion on the need for revisions to specific language. In October 2008, GRWG consulted ACIP to determine the best mechanism for approving the resulting document. ACIP concluded that the document could be approved and finalized incrementally, with a final vote on the entire document.

Revisions to the following sections were approved through consensus vote in October 2008 (i.e., were approved as a part of the entire document and not through separate votes on each section): 1) Timing and Spacing of Immunobiologics; 2) Contraindications and Precautions; 3) Preventing and Managing Adverse Reactions; 4) Reporting Vaccine Adverse Events; 5) the National Vaccine Injury Compensation Program; and 6) Vaccine Administration. In February 2009, revisions were made to Storage and Handling of Immunobiologics, and ACIP approved the section. In June 2009, ACIP voted to incorporate the contents of a 1999 ACIP statement on combination vaccines. The statement was revised by GRWG and the ACIP Combination Vaccines Work Group. ACIP also approved minor changes to the section on Special Situations and the section on Vaccination Records. In October 2009, ACIP voted to revise the entire *General Recommendations on Immunization*, which incorporated ACIP recommendations on adolescent vaccination (1996) and adult vaccination (1991) into the section on Vaccination Programs. Three votes were taken to approve various sections of the document, and one vote was taken to approve the entire document. At this final meeting, ACIP also discussed concerns about the lack of evidence that supports use of antipyretics before or at the time of vaccination for the prevention of fever. Consequently, CDC added information highlighting the lack of evidence for the use of antipyretics to the section on Methods for Alleviating Discomfort and Pain Associated with Vaccination. The last meeting of GRWG was held on December 2, 2009. This meeting served solely to update the work group regarding the discussions and vote of the October 2009 meeting and CDC deliberations on changes to the recommendations on the use of antipyretics.

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

The guideline developers reviewed published cost analyses.

Method of Guideline Validation

Peer Review

Description of Method of Guideline Validation

Not stated

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is not specifically stated for each recommendation.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Potential Benefits

- Benefits of vaccination include partial or complete protection against infection for the vaccinated person and overall benefits to society as a whole. Benefits include protection from symptomatic illness, improved quality of life and productivity, and prevention of death. Societal benefits include creation and maintenance of herd immunity against communicable diseases, prevention of disease outbreaks, and reduction in health-care-related costs.
- Potential benefits of combination vaccines
    - Improved vaccine coverage rates
    - Timely vaccination coverage for children who are behind the schedule
    - Reduced shipping and stocking costs
    - Reduced costs for extra health-care visits necessitated by deferral of vaccination
    - Facilitation of additional new vaccines into vaccination programs

Potential Harms

- Vaccine adverse reactions are classified as 1) local, 2) systemic, or 3) allergic. Local reactions (e.g., redness) are usually the least severe and most frequent. Systemic reactions (e.g., fever) occur less frequently than local reactions, and severe allergic reactions (e.g., anaphylaxis) are the least frequent reactions. Severe adverse reactions are rare.
- Syncope (vasovagal or vasodepressor reaction) can occur after vaccination and is most common among adolescents and young adults.
- Needle-stick injuries may occur among health-care workers, with the consequent risk for bloodborne diseases acquired from patients.
- Vaccine components can cause allergic reactions among certain recipients. These reactions can be local or systemic and can include mild to severe anaphylaxis or anaphylactic-like responses (e.g., generalized urticaria or hives, wheezing, swelling of the mouth and throat, dyspnea, hypotension, and shock).
- The administration of the combination measles, mumps, rubella, and varicella (MMRV) vaccine is associated with risk for febrile seizures.

Risks of Combination Vaccines

- Adverse events might occur more frequently
- Confusion and uncertainty about selection of vaccine combinations and schedules for subsequent doses, especially when vaccinations are given by multiple providers who might be using different products
- Reduced immunogenicity of one or more components
- Extra doses of certain antigens in the fixed product (e.g., a provider who uses DTaP-hepatitis B-IPV vaccine will give an extra dose of hepatitis B component)
- A shorter shelf-life than the individual component vaccines

Specific Vaccine-Related Harms

See Table 6 in the original guideline document for possible side effects from commonly used vaccines.

Contraindications

Contraindications

- The only contraindication applicable to all vaccines is a history of a severe allergic reaction (i.e., anaphylaxis) after a previous dose of vaccine or to a vaccine component (unless the recipient has been desensitized; see Special Situations section in the original guideline document). In addition, severely immunocompromised persons generally should not receive live vaccines. Children who experienced encephalopathy within 7 days after administration of a previous dose of diphtheria and tetanus toxoids and whole-cell pertussis vaccine (DTP), diphtheria-tetanus-acellular pertussis vaccine (DTaP), or tetanus-diphtheria acellular pertussis vaccine (Tdap) not attributable to another identifiable cause should not receive additional doses of a vaccine that contains pertussis. Because of the theoretical risk to the fetus, women known to be pregnant generally should not receive live, attenuated virus vaccines (see Special Situations section in the original guideline document).
- See the "Major Recommendations" section of this summary and Table 6 of the original guideline document for a more complete discussion of contraindications and precautions to commonly used vaccines.

Qualifying Statements

Qualifying Statements

- These recommendations are intended for use in the United States; vaccine availability, use, and epidemiologic circumstances might differ in other countries and might warrant different recommendations.
- The *Recommended Immunization Schedules for Persons Aged 0 Through 18 Years* and the *Recommended Adult Immunization Schedule* are revised annually. Physicians and other health-care providers should ensure that they are following the most up-to-date schedules, which are available from the Centers for Disease Control and Prevention (CDC) .
- Use of trade names and commercial sources is for identification only and does not imply endorsement by the U.S. Department of Health and Human Services.
- References to non-CDC sites on the Internet are provided as a service to Morbidity and Mortality Weekly Report (MMWR) readers and do not constitute or imply endorsement of these organizations or their programs by CDC or the U.S. Department of Health and Human Services. CDC is not responsible for the content of pages found at these sites. URL addresses listed in MMWR were current as of the date of publication.
- This report will not include any discussion of the unlabeled use of a product or a product under investigational use with the exception of the following situations:
    1. The nonsimultaneous administration of yellow fever (YF) vaccine and inactivated vaccines.
    2. Simultaneous administration of an inactivated and live vaccine (e.g., pneumococcal polysaccharide vaccine [PPSV] and zoster [Zos] vaccine).
    3. Interchangeability of combination vaccines and single-component vaccines (e.g., using single-component *Haemophilus influenzae type b* [Hib], diphtheria and tetanus toxoids and acellular pertussis (DTaP), and inactivated poliovirus [IPV] for later doses in series, after a series has begun with DTaP-IPV/Hib).
    4. Interchangeability of brands of combination vaccines and single-component vaccines (e.g., using DTaP-IPV/Hib and single-component hepatitis B [Hep B] vaccine for later doses in series that might have previously included DTaP-IPV-HepB and Hib).
    5. Rotarix and RotaTeq need not be repeated if an infant spits up or regurgitates a dose.
    6. Contact allergy to latex is neither a contraindication nor a precaution to the use of quadrivalent meningococcal conjugate vaccine (MCV4) in the absence of an anaphylactic allergy.
    7. No need to repeat a dose of MCV4 vaccine given subcutaneously.
    8. Revaccination with MCV4.
    9. Appropriate storage and handling for the following vaccines at 35°F–46°F:
        - DTaP
        - Hib
        - Hepatitis A
        - Hepatitis B
        - Human papillomavirus (HPV)
        - PPSV
        - Measles, mumps, and rubella (MMR)
        - Pneumococcal conjugate vaccine (PCV)
        - Rotavirus (RV)
        - Tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) vaccine
        - Trivalent inactivated influenza vaccine (TIV)
    10. Initiation of live Zos vaccine in immunocompetent patients 3 months after remission from chemotherapy.
    11. Avoiding conception for 1 month after vaccination with MMR or varicella (Var) vaccine.
    12. A minimum age of 12 months for the fourth dose of DTaP.
    13. Use of pneumococcal conjugate vaccine and *Haemophilus influenzae b* vaccine in persons receiving hematopoietic cell transplant or who are infected with human immunodeficiency virus, regardless of age.

Implementation of the Guideline

Description of Implementation Strategy

Vaccination Programs

Universal vaccination is a critical part of quality health care and should be accomplished through routine and catch-up vaccination provided in physicians' offices, public health clinics, and other appropriate complementary settings. Every patient encounter represents an opportunity to review and, when needed, improve a patient's vaccination status through administration of recommended vaccines.

See Table 15 in the original guideline document for a summary of recommendations for interventions to improve coverage of vaccines recommended for routine use among children, adolescents, and adults.

Vaccination of Children and Adolescents

Physicians and other pediatric vaccination providers should adhere to the standards for child and adolescent vaccination practices. These standards were published by the National Vaccine Advisory Committee and define appropriate vaccination practices for both public and private sectors. The standards provide guidance on practices that eliminate barriers to vaccination, including eliminating unnecessary prerequisites for receiving vaccinations, eliminating missed opportunities to vaccinate, improving procedures to assess vaccination needs, enhancing knowledge about vaccinations among parents and providers, and improving management and reporting of adverse events. In addition, the standards address the importance of recall and reminder systems and using assessments to monitor clinic or office vaccination coverage levels. Health-care providers should simultaneously administer as many vaccine doses as possible as indicated on the *Recommended Immunization Schedules for Persons Aged 0 Through 18 Years*.

Community health-care providers, as well as staff members at both state and local vaccination programs, should coordinate with partners to maximize outreach to populations at risk for undervaccination and vaccine-preventable diseases. For example, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a categorical federal grant program administered by the U.S. Department of Agriculture through state health departments. The program provides supplemental foods, health-care referrals, and nutrition education to low-income pregnant, breastfeeding, or postpartum women, as well as to infants and children aged <5 years. More than 8.7 million people participated in this program in 2008 (http://www.fns.usda.gov/pd/wicmain.htm). In collaboration, WIC and state vaccination programs should assess regularly the vaccination coverage levels of WIC participants and develop new strategies and aggressive outreach procedures in sites with coverage levels <90%. Vaccination programs and private providers are encouraged to refer eligible children to obtain WIC nutritional services.

Adolescents

To ensure vaccine coverage, clinicians and other health-care providers who treat adolescents must screen for a complete vaccination history on every occasion that an adolescent has an office visit.

Ensuring adolescents receive routine and catch-up vaccination and increasing vaccination coverage in this age group presents challenges. In general, adolescents do not visit health-care providers frequently. Health-care providers should promote annual preventive visits, including one specifically for adolescents aged 11 and 12 years. The annual visits should be used as opportunities to provide routinely recommended vaccine doses, additional catch-up doses needed for lapsed vaccine series, vaccines recommended for high-risk groups, additional doses that might have been recently recommended, and other recommended health-care services.

All vaccine doses should be administered according to Advisory Committee on Immunization Practices (ACIP) vaccine-specific statements and with the most recent schedules for both routine and catch-up vaccination. Before leaving any visit for medical care, adolescents should be encouraged to schedule return visits for any additional vaccine doses needed. During visits that occur outside of influenza season, providers should discuss and recommend seasonal influenza vaccination and make explicit plans for vaccination, including timing and anticipated setting (e.g., health-care provider's office, school, or pharmacy). Catch-up vaccination with multidose adolescent vaccines generally can occur according to the routine dosing schedule for these vaccines, although in some circumstances the clinician or health-care provider might use minimum intervals for vaccine doses. These circumstances include an outbreak that increases risk for disease or the likelihood that doses will be missed in the future (e.g., because of an impending loss of health-care coverage or transportation challenges). Because of lack of efficacy data for HPV vaccine administration using minimum intervals, providers are encouraged, when possible, to use routine dosing intervals for females aged 11–26 years who have not yet received 3 HPV vaccine doses as recommended.

One of the challenges of adolescent vaccination is ensuring that current, complete vaccination histories are available. Insurers, covered services, or reimbursement levels can change, and these changes might affect reimbursement for vaccine doses and vaccination services directly while also causing disruptions in an adolescent's access to vaccination providers or venues. In circumstances in which a vaccination record is unavailable, vaccination providers should attempt to obtain this information from various sources (e.g., parent, previous providers, or school records). More detail about how to obtain these records is available from the Centers for Disease Control and Prevention (CDC) Web site . With the exception of influenza and pneumococcal polysaccharide vaccines, if documentation of a vaccine dose is not available, the adolescent should be considered unvaccinated for that dose. Regardless of the venue in which an adolescent receives a dose of

vaccine, that vaccine dose should be documented in the patient's chart or in an office log, and the information should be entered into an immunization information system (IIS). The adolescent also should be provided with a record card that documents the vaccination history.

Adult Vaccination

Because of recent licensure of new vaccines approved for adults and new ACIP recommendations for the use of many vaccines in adults, providers of adult health care now share a greater responsibility for putting these recommendations into practice.

In 2003, the National Vaccine Advisory Committee published standards for adult vaccination. These standards include ensuring vaccine availability, review of records, communicating the risks and benefits of vaccination, use of standing orders, and recommending simultaneous administration of all indicated doses according to the *Recommended Adult Immunization Schedule*.

Vaccination rates in adults are considered suboptimal. New *Healthy People 2020* goals for influenza and pneumococcal polysaccharide vaccines include specific subsets of adults, including institutionalized adults aged ≥18 years (for both influenza and pneumococcal polysaccharide vaccines) and noninstitutionalized adults at high risk aged >18 years (for pneumococcal polysaccharide vaccine).

The most substantial barrier to vaccination coverage is lack of knowledge about these vaccines among adult patients and adult providers. Other barriers are cost (lack of additional insurance to Medicare) and the lack of financing mechanisms for newly licensed and recommended vaccines.

A common challenge for health-care providers is vaccinating adults with unknown vaccination records. In general (except for influenza and pneumococcal polysaccharide vaccines), adults should receive a vaccine dose if the dose is recommended and no record of previous administration exists. If an adult has a record of military service and does not have records available, providers can assume that the person has received all vaccines recommended by the military at the time of service entry. Serologic testing might be helpful in clarifying immune status if questions remain because at different times and depending on military assignments, there might be interservice and individual differences.

Evidence-Based Interventions to Increase Vaccination Coverage

The independent, nonfederal Task Force on Community Preventive Services, whose membership is appointed by CDC, provides public health decision-makers with recommendations on population-based interventions to promote health and prevent disease, injury, disability, and premature death. The recommendations are based on systematic reviews of the scientific literature about effectiveness and cost-effectiveness of these interventions. In addition, the task force identifies critical information about the other effects of these interventions, the applicability to specific populations and settings, and the potential barriers to implementation. Additional information, including updates of published reviews, is available from The Community Guide.

As recognized by the task force, routine assessment and feedback of vaccination rates obtained at the provider site is one of the most effective strategies for achieving high, sustainable vaccine coverage. Since 1995, all states receiving federal funds for vaccination programs have been required to conduct annual assessments of vaccination rates both in public health clinics and in private provider offices. Primarily to aid local and state health departments in their efforts to conduct assessments and assist providers, CDC has developed numerous software applications to measure vaccination rates in provider practices.

Vaccine Information Sources

See the original guideline document for sources of specific and updated vaccine information.

Implementation Tools

Chart Documentation/Checklists/Forms

Foreign Language Translations

Patient Resources

Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report

Categories

IOM Care Need

Staying Healthy

IOM Domain

Effectiveness

Patient-centeredness

Safety

Identifying Information and Availability

Bibliographic Source(s)

National Center for Immunization and Respiratory Diseases. General recommendations on immunization. Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Surveill Summ. 2011 Jan 28;60(2):1-64. [239 references] PubMed

Adaptation

Not applicable: The guideline was not adapted from another source.

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Guideline Developer(s)

Centers for Disease Control and Prevention - Federal Government Agency [U.S.]

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Financial Disclosures/Conflicts of Interest

Disclosure of Relationship

The Centers for Disease Control and Prevention (CDC), their planners, and their content experts wish to disclose that they have no financial interests or other relationships with the manufacturers of commercial products, suppliers of commercial services, or commercial supporters.

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Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Kroger AT, Atkinson WL, Marcuse EK, Pickering LK, Advisory Committee on Immunization Practices (ACIP) Centers for Disease. General recommendations on immunization: recommendations of the Advisory Committee on Immunization Practices (ACIP) [published errata appear in MMWR Morb Mortal Wkly Rep 2007 Mar 23;56(11):256]. MMWR Recomm Rep 2006 Dec 1;55(RR-15):1-48.

Centers for Disease Control and Prevention (CDC), Advisory Committee on Immunization Practices (ACIP). Update: recommendations from the Advisory Committee on Immunization Practices (ACIP) regarding administration of combination MMRV vaccine. MMWR Morb Mortal Wkly Rep 2008 Mar 14;57(10):258-60.

The Advisory Committee on Immunization Practices (ACIP) General Recommendations Work Group (GRWG) revises the General Recommendations on Immunization every 3 to 5 years.

Guideline Availability

Electronic copies: Available from the Centers for Disease Control and Prevention (CDC) Web site .

Print copies: Available from the Centers for Disease Control and Prevention (CDC), *MMWR*, Atlanta, GA 30333. Additional copies can be purchased from the Superintendent of Documents, U.S. Government Printing Office (GPO), Washington, DC 20402-9325; (202) 783-3238.

Availability of Companion Documents

Figure 6 of the original guideline document contains a sample temperature log for vaccines.

Additionally, resources on vaccines and immunizations for health care professionals are available in Spanish and English from the Centers for Disease Control and Prevention Web site .

Patient Resources

Patient resources on vaccines and immunizations are available in English and Spanish from the Centers for Disease Control and Prevention (CDC) Web site .

Please note: This patient information is intended to provide health professionals with information to share with their patients to help them better understand their health and their diagnosed disorders. By providing access to this patient information, it is not the intention of NGC to provide specific medical advice for particular patients. Rather we urge patients and their representatives to review this material and then to consult with a licensed health professional for evaluation of treatment options suitable for them as well as for diagnosis and answers to their personal medical questions. This patient information has been derived and prepared from a guideline for health care professionals included on NGC by the authors or publishers of that original guideline. The patient information is not reviewed by NGC to establish whether or not it accurately reflects the original guideline's content.

NGC Status

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the market and the release of heightened warnings for Celebrex (celecoxib) and other nonselective nonsteroidal anti-inflammatory drugs (NSAIDs). This summary was updated by ECRI on June 16, 2005, following the U.S. Food and Drug Administration advisory on COX-2 selective and non-selective non-steroidal anti-inflammatory drugs (NSAIDs). This summary was updated by ECRI on October 5, 2005 following the U.S. Food and Drug Administration (FDA) advisory on Menactra (Meningococcal Conjugate Vaccine A, C, Y, and W135). This summary was updated by ECRI on October 25, 2006 following the updated FDA advisory on Menactra (Meningococcal Conjugate Vaccine). This NGC summary was updated on January 2, 2007. This summary was updated by ECRI on February 19, 2007 following the FDA advisory on Rotavirus, Live, Oral, Pentavalent vaccine (RotaTeq). This summary was updated by ECRI Institute on July 9, 2007 following the FDA advisory on RotaTeq (Rotavirus, Live, Oral, Pentavalent) vaccine. This NGC summary was updated most recently by ECRI Institute on March 27, 2008. This summary was updated by ECRI Institute on March 10, 2009, following the U.S. Food and Drug Administration advisory on Topical Anesthetics. This summary was updated by ECRI Institute on April 1, 2010 following the U.S. Food and Drug Administration advisory on Rotarix Vaccine. This summary was revised by ECRI Institute on June 3, 2010 following the updated U.S. Food and Drug Administration advisory on Rotarix Vaccine. This summary was updated by ECRI Institute on November 12, 2010 following the U.S. Food and Drug Administration (FDA) advisory on Afluria (influenza virus vaccine). This NGC summary was updated by ECRI Institute on April 18, 2011.

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